Reed a Renewable Resource

A commercially attractive use of Reed as a Renewable Resource which mitigates the impact of the invasion of reed in the Senegal River Delta

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Background:
Matching nature conservation and commerce.

- Reed grows in wetlands. Wetlands are increasingly considered valuable and ecologically essential. The growing consensus is thus that: “Wetlands are to be conserved and protected”.
- Conservation is often controversial, but if wetlands have besides an ecological value also a commercial value and generate a direct income, there are additional arguments for its conservation.
- Reed growth is/can be invasive and is difficult, if not impossible, to eradicate.
- But : Regular harvesting and giving value to reed will control the invasion, mitigate the impact and can “turn a curse (partly) into a blessing”.

Against this background RVI developed a business plan for the exploitation of invasive reed on the south bank of the delta of the Senegal River.

Reed Valorization Initiative

Location of the Senegal River and harvesting areas

A problem→ a source of renewable biomass→ a commercially attractive resource with national benefits.

The national practically unsolvable problem in Senegal and Mauretania:

Invasion of reed (Typha, Phragmites) invaded the Senegal River bed and delta after dam construction. Reed covered area estimated: 100 000ha (?);

The resource:

Annually biomass : estimated ± 1 million tons dry matter (?)
moisture content :± 50-60% (?); energy content : >16.5 GJ/ton.

Possible exploitation of the reed resource consists of:

Harvesting + transporting the reed in inundated fields to dryland, drying the reed, baling the reed for transport to end-user→ end –user uses the reed as a bio-fuel for co-combustion with coal (50 000 tons/year).

National benefits:

Mitigates the reed invasion problem, creates > 75 labour places, replaces coals and is thus an energy import substitution which reduces CO_2 emission.

Reed is a potential raw material for the production of high(er) value products.

Reed can be used as a renewable raw material for:

- Bio-fuel: direct combustion (briquettes, pellets), bio coal, charcoal replacement, gas, 2nd generation ethanol.(technologies are available)
- Building materials: Panel board, Building blocks.(technologies available).
- Textile fibres: Cotton replacement.(technology proven, but to be fine-tuned).

Commercial production of most of these products require:

- annually large volumes and a regular supply;
- a sophisticated and investment intensive downstream industry (including a technical support infrastructure);
- substantial reliable electricity supply;
- infrastructure for commercialisation.

The initial choice for the Senegal River Delta: use of reed as a bio-fuel for co-combustion with coal, avoiding complex downstream infrastructure

- Chipped and dried reed can be directly used in cement kilns where it can be co-combusted with coal.(there is an existing demand, no downstream processing required).
- To limit transport cost of voluminous reed, the reed is chipped and compressed into industrial bales. (± 400 kg/m^3).
- Pelleted reed (700kg/m^3) is preferred by coal burning (power) plants, because pellets can be mixed with coal for milling in hammer mills. This was considered but pelleting requires considerable amounts of electric power and sophisticated downstream equipment. Therefore: pelleting was rejected.
- Main technical and cost hurdles in such a supply chain for chipped reed bales are:
  - Harvesting: specially in-field transport in inundate areas.
  - Transport (cost, distances, road conditions) to end user of low value, reduced but still voluminous, reed bales .

Conditions for making reed bio-fuel commercially attractive

For the **end user (client)** reed biofuel is attractive if:

- The cost per thermal unit delivered at the point of use (factory gate) is competitive with alternatives.
- A continuous, daily, reliable supply can be guaranteed.(10 months/year)
- The volumes supplied are in line with the requirements to make its use and the required infrastructure at the plant cost effective(±50 000tons/year).

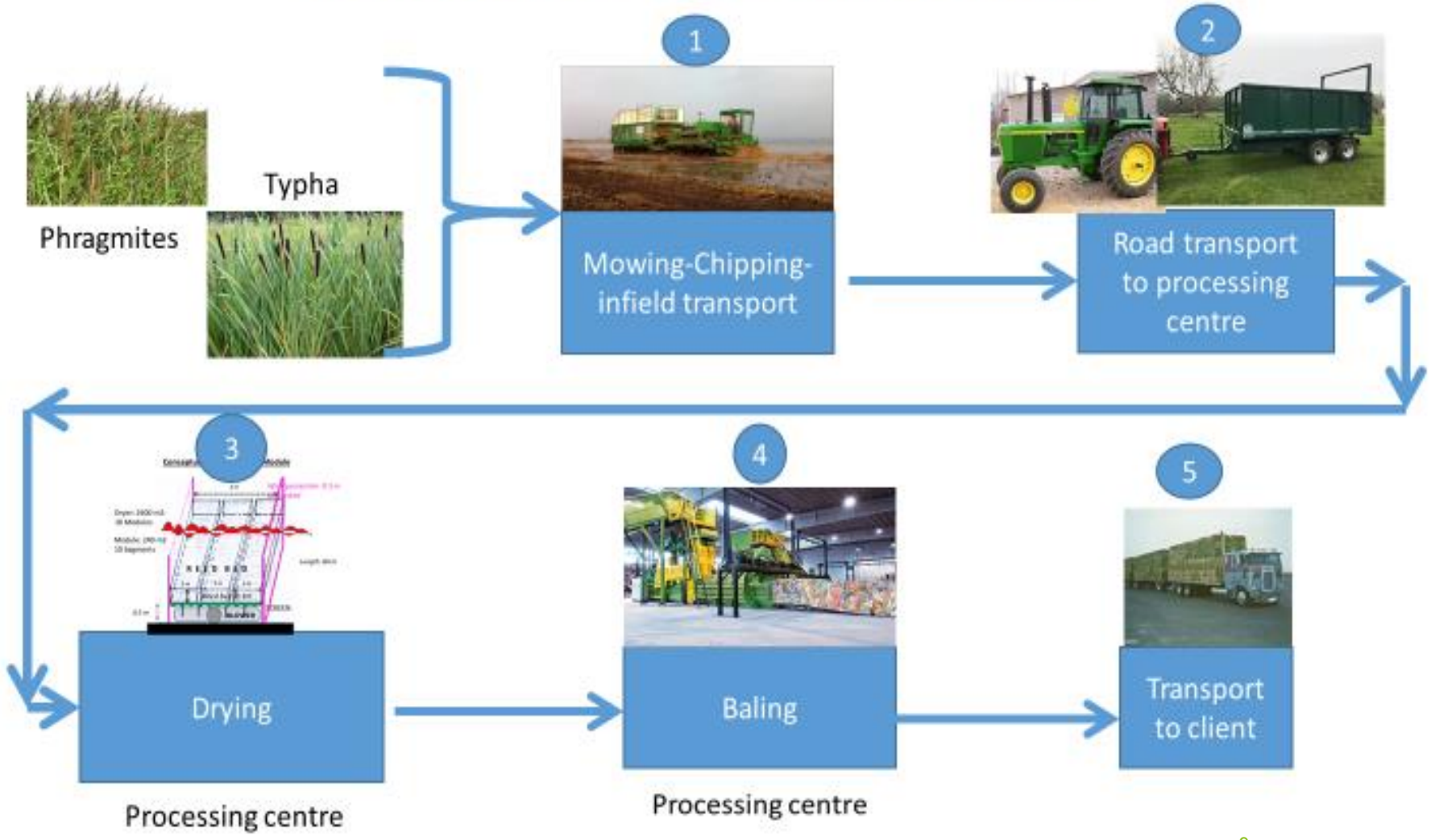
For the **entrepreneur** a business which supplies reed biofuel is attractive if:

- Sales price covers: production cost+ capital cost+ profit margin.
- Payback period <5-6 years,
- IRR >15-20%.

The business case of a:
A Reed- Biofuel Supply Chain

Is based for its initial phase on: reed growing on 5 000- 7 000 ha in the Senegal River delta which supplies annually (10 months) ± 50 000 tons of bio-fuel to the Senegalese cement industry
located at a distance of 250 km.

The Reed Bio-Fuel Supply Chain



1. Harvesting and in-field transport: Otter Reed combine harvester (Hanze Wetlands)

Otter consists of two parts: mowing unit and trailer.
Mowing unit : mows ->collects reed-> chips reed ->blows chips into trailer.
Trailer compacts reed > tips to unload.

Characteristics Otter reed harvester:

- Ground pressure: 85 gr/cm^2 (norm<150gr/cm^2)
- Prime mover and trailer powered
- Can work in up to 1m water depth
- Capacity mowing : 40 tons/h
- Travel speed 10- 20 km/hour
- Capacity transport 50 m^3 = 10-20/t
- Cycle time (1 km in-field transport): 35 minutes average.

Daily production of 280 tons wet reed can be reached with:

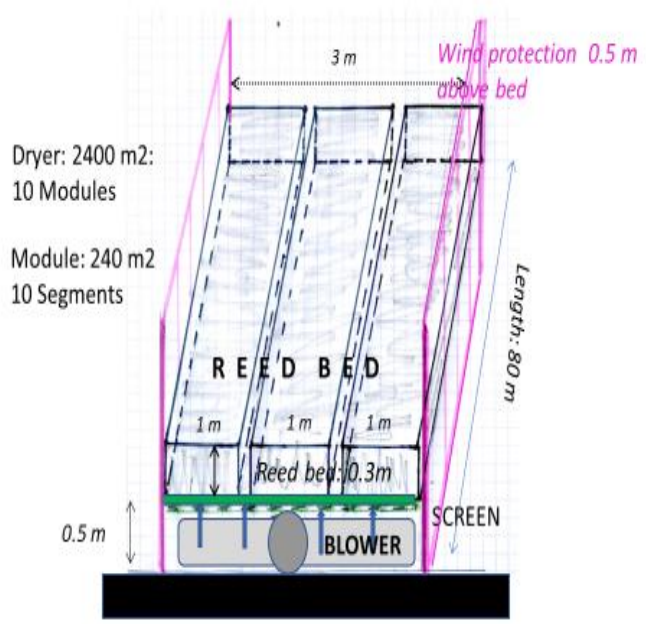
2 Otter Combine Reed Harvesters.

2. Road transport to Processing Centre

- Transport unit:

  Tractor + 2 trailers (2 x 10 tons)
- Transport distance: average 8.5 km.
- Travel speed: 15- 25 Km/h
- Required number units: 3

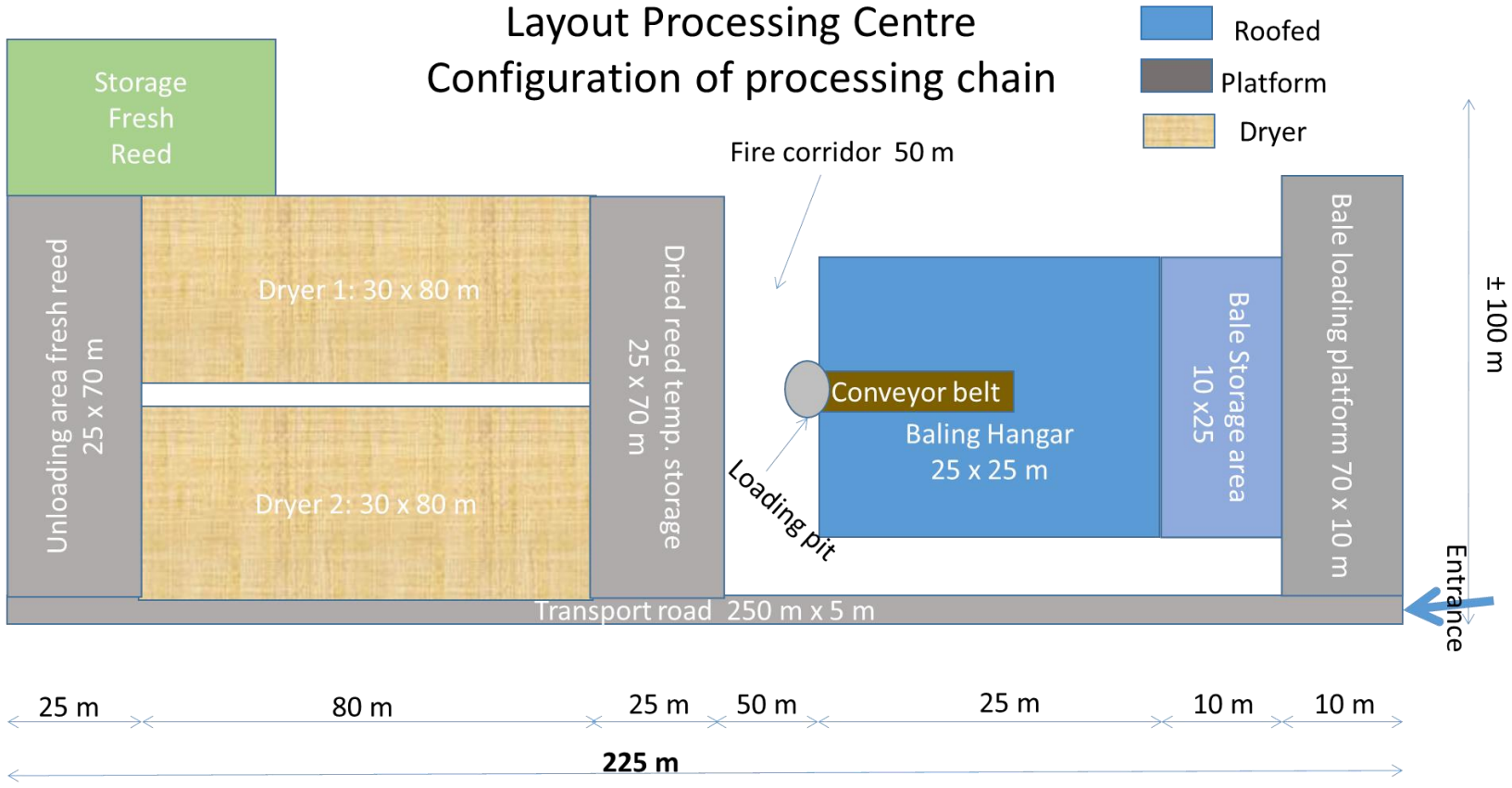
3. Air-forced sun-drying in Processing Centre



- Reed chips spread out on perforated drying floors in layers of 0.3m.
- Ambient (hot-dry)air blown through perforations.
- Reed chips will be regularly turned and mixed
- Drying time 2-3 days, for reduction of moisture content of ±40%-50% to ±12%.
- Blowers can be powered by solar energy.

4. Baling of chipped dried reed.

- Baling with an industrial baler into bales of 1m ^{3} (400kg).
- Agricultural balers cannot reach required densities. (transport cost)
- Binding with steel wire.
- Production 20 tons/h (=50 bales/h).



NOT TO SCALE

Functions: Temporary storage reed chips and bales, drying and baling the reed chips; staff facilities and servicing facilities for equipment and machinery .

Possibilities for including facilities for processing reed into higher value products like charcoal- bio-coal etc..

5. Transport of baled dry reed chips to end-user

- Daily tasks: Transport 160 tons (400 m^3); Distance ± 250 km of which 12 km is gravel road.
- Transport material: high volume truck with trailer (2 x 45 m^3).
- Cycle time: driving time 2 x 6 hours; including time for loading + unloading : 1 trip per day(= 24 hours).
- Number of trucks required: 4- 5.

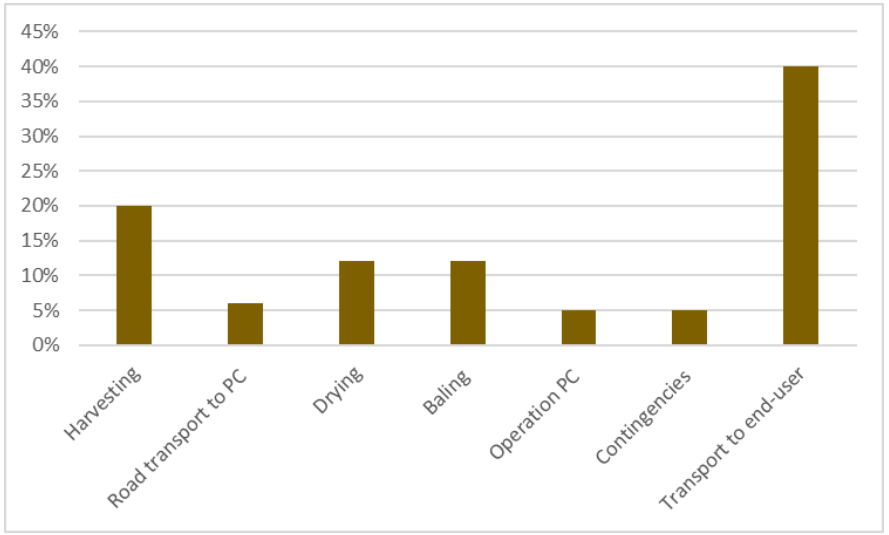
Investments for, and production costs of, baled reed chips production and transport

Investments

Investments excluding import duties including, engineering and contingencies, are estimated at:

- €4 million in case transport is outsourced.
- Additionally €1 million if equipment for transport to end-user is included.

Break down of net cost reed bales supplied to end user



Potential savings and additional income

Savings:

- Return freight: if return freight can be obtained savings of 10% (estimate).
- Dry matter yields/year: 15 tons/ha instead of 10 tons/ha→ reduces harvesting and transport costs to the processing centre.

Extra income:

- Carbon Certificates can generate extra income: ±€8-€9/ton reed, based on value CO_2 of €6/ton which is expected to increase within a decade to €20-€40/ton CO_2.

Potential additions to Processing centre which could generate additional income:

Pilot production of (higher value) charcoal replacement by torrefaction/pyrolysis of reed for use as charcoal by local population. Such pilot production can make use of reed supply and technical infrastructure of the processing centre.

Key financial indicators

Based on sales price per GJ equivalent to current world market cost price of coal delivered at site.

Base case: Low yield, no savings on transport without and with carbon certificates.

- Internal rate of return: 16%-33%
- Payback period: 5-4 years
- EBIT: €0.7 -€1.3 mill.
- EBT: €0.6- €1.3 mill.
- NPV €1.6-€4.4 mill.

Conclusion:

Commercially interesting to attractive.

Optimistic case: High yield, low transport cost without and with carbon certificates

- Internal rate of return: 24%-39%
- Payback period: 4-3 years
- EBIT: €1.0 -€1.7 mill.
- EBT: €0.9- €1.6 mill.
- NPV €2.9-€6.2 mill.

Conclusion:

Commercially attractive to very attractive.

Actions required before implementation
(costs included in investment costs)

- Detailed engineering of infrastructure especially the Processing Centre.
- Detailed design of drying arrangements based on detailed meteorological data and local reed characteristics.(involves laboratory tests).
- Detailed delimitation seasonal water depths in harvesting sites based on water level management at dam site (criterion more or less than 1 m).
- Environmental impact assessment (if legally required).
- Administrative arrangements with transnational (OMVS), national and local authorities.

Conclusion

- **Commercially:** Based on the present (low) world market coal price of ± $75/ton FOB, in the Senegalese case a Reed Bio-Fuel Supply Chain is an interesting commercial proposition requiring relative limited investments.
- Since the area covered with reed (±100 000ha) is considerable: significant expansion of production both in Senegal and Mauritania is possible.
- **On national level**: Mitigates the reed invasion problem, creates labour places, and realises import substitution (coal) and foreign exchange savings.
- **On international level**: Reduces CO_2 emission, helps meeting the objectives of the Paris Agreements (2015), proves the value of reed as a reliable renewable energy source, proves the commercial value of wetlands exploitation and can serve as model for other countries (Nigeria, Chad, Niger, Ivory coast, etc.)

But:

- The supply chain requires: a well organised staff and management for implementing and managing an initially complex supply chain as well as the cooperation of the authorities and government.

Future development

- Dangote Cement Senegal has decided to initialise the Reed Bio-Fuel Supply Chain in Senegal and use the reed chips for co-combustion in its cement-kilns.
- Since the concept is innovative with the pertaining uncertainties and risks, and the present cost of coal is for Dangote Cement Senegal lower than the international cost, they have decided to implement the supply chain as a part of their Corporate Social Responsibility Programme.
- Dangote Cement Senegal has the capacity to professionally implement and manage the supply chain.
- The “Reed Valorization Initiative” will cooperate, advise and coordinate the implementation.

THANK YOU FOR YOUR ATTENTION